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Zenon S. Zannetos

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Zenon S. Zannetos*

One of the major reasons behind decentralization, is the creation of "substabilities" for the elimination of uncertainty. As the term is used here, within the context of organization theory, a "substability" is a semi-autonomous entity, a partial fixity, or semi-permanence within the total organization. By means of such a device, the organization allows and enables the various subentities within it to develop plans and operations on the basis of externally unconditional expectations for the duration of the planning cycle, and thus reach positions of partial equilibrium. It is in other words a stepping stone in the process of problem solving, a device by means of which external to the subunit relationships are assumed frozen. External interference and intercorrelations are thus minimized for the creation of a semblance of order, within which specialization can be achieved.

Relative independence for planning and execution of plans is quite crucial not only because complex organizations require uninterrupted concentration for learning and specialization, but also for reasons of motivation. By freezing a lot of variables one can often identify cause and effect, and so

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associate end results with human behavior and effort, although in a limited sense. But how efficient is the end result for the total organization? Is there any way one can look at a given structure and decide whether a reorganization will bring about beneficial results? And if so, how can one relegate this function to the information system of the firm so as to take advantage of changing functional relationships? The purpose of this paper is to deal with some of these questions.

Elsewhere [5], we have examined the factors that affect centralization and decentralization. We pointed out that one of the effects of decentralization is that it reduces, and in some cases eliminates, the necessity for mutual interaction of interdependent subentities within the organization, and therefore reduces instabilities and mitigates the consequences of partial failures. Within a decentralized organization, as a result, we find in various degrees that:

1. The amount of information that is transmitted between units is reduced, as specialized knowledge generated within units substitutes direction that emanates from the outside.

2. The results of operations are additive.

3. Motivation for improvements is enhanced because the operating statements of subunits reflect the results of internal efforts.

4. There exists flexibility for the absorption of shocks from adversity which may otherwise be very damaging to the total organization, and ability to adapt to changes in the immediate environment with minimum delay.

5. Parts of the entity and its mission can survive although the total mission may not be accomplished.

6. Specialized knowledge is a vital ingredient of the technology of the firm.

The benefits of decentralization are not obtained of course without a cost. Any simplifying assumption for purposes of problem solving which keeps external relationships constant, harbors its own dangers and may result in solutions that are addressed to the wrong problem. Similarly, in the case of decentralized structures, the decisions made for partial equilibrium purposes do not as a rule encompass the "global" aspects of the problem, and often the costs of suboptimization may more than negate the advantages of uncertainty elimination, motivation, learning and specialization.

Furthermore, as "stepping stones" are only means to an end, so the organizational substabilities may be obviated by the knowledge gained from the solution of the original problem. As a result, unless the conditions that initiated a particular pattern of divisionalization continue to exist, that is to say unless the solution of a problem opens the door to solutions of higher level problems with the same generic characteristics, the organization structure must be changed in response to the effected changes in the environment.

II. Problems in Measurement

A. Method

The assessment of the overall efficacy of operating organization structures is very difficult, because of the complicated interrelationships between the various aspects of divisionalization. Theoretical solutions have not alleviated this problem not so much because theory is inapplicable, but because we have

not as yet developed meaningful tools for empirical measurements. As a result the empirical investigator has been often forced to resort to measures of efficiency that are not only partial but also particular to the organization being studied.

Assuming that the elimination of uncertainty inherent in plans and operations is the major motivating factor behind divisionalization, we suggested previously [5] that the results of operations of subentities be subjected to covariance analysis. The reasons behind this suggestion are as follows: We know that the variance of the sum of interdependent entities is equal to the sum of their variances plus twice the sum of their covariance taken two at a time. Consequently, if the covariances are positive, then the variance of the sum is greater than the sum of the variances, and if negative it will be smaller.

Decentralization attempts to create independent subentities. If divisionalization is successful, therefore, then the performance of each and every subunit to the extent of being independent of that of the rest, should result in zero covariances. If, on the other hand, as is often the case, independence cannot be obtained, then by artificial buffering an efficient organization should develop uncorrelated subentities which again will reduce the covariances to zero. Hence covariance analysis can lead us to those areas where divisionalization has failed to achieve its purpose of uncertainty reduction.[1]

We must note that in this case the purposes of covariance analysis, and any consequent reorganization, is not so much to reduce the variance inherent in plans and operations by hook or by crook, but to utilize the information gained for better planning. Whenever the covariances between any two of these subentities is large,[2] no matter whether it is negative of positive, it must

be used as a signal for further investigation into these relationships. Negative covariances normally indicate the necessity for recentralization, so as to take advantages of the slack induced by the subentities on each other and avoid the wasting of resources. By allowing therefore subentities to plan on an independent basis in the presence of negative covariances, the organization misses an opportunity for reducing the overall variance, and capitalizing on the functional relationships that the negative covariance suggests. The probability is quite large that without the artificial independence the negative covariance would have been even larger, as will soon show with an example, and the potential benefits of centralization much greater. The negative correlation in this case should be accentuated, because it provides flexibility in the utilization of key resources.

Positive covariances indicate the need for further buffering of the subentities, so that the detrimental consequences of accidents or faulty plans and operations are not transmitted from subunit to subunit and amplified within the total organization. Decentralization as a result should be strengthened in the presence of positive covariances, and the positive correlation between subentities reduced.

Having isolated the areas within the organization that need attention, the next step is to obtain the functional relationships between the subunits in a form that will aid planning and projections. Afterall the end result of such an exercise is a better understanding of the state of nature, and utilization of such knowledge in planning the organization structure and operations efficiently. So we subject the components of the covariance to an analysis of variance. In effect we test random models of the form:

$$X_{i,\ldots,k} = \mu + A_i + \ldots + T_k + \varepsilon_{i,\ldots,k}$$

where X is the variable we want to observe,

μ the common factor among all observations,

$A_{i,\ldots,}T_k$ are the "operators" or factors affecting the level of observations, and

$\varepsilon_{i,\ldots,k}$ is the residual random error which is due to time, behavior changes etc., and which is assumed to be normally and independently distributed with mean zero and variance σ_e^2 which is assumed constant at all levels.

By means of the above model we can determine the components of the total variance, by proceeding in one of two ways. We can first obtain the sums of squares by either the traditional analysis of variance method or by subjecting the model to a general regression significance test. The latter is more flexible and can be adapted to provide at the same time check on data used by accounting standard systems. Orthogonal contrasts can provide information on the significance of the differences in performance within each identifiable causal factor.

In addition to running the models with observation that are not stratified--the observations may be completely randomized, randomized within blocks or cells depending on the particulars of the experiment--a stratification is advisable to ascertain whether significantly different relationships exist for variations above versus below the overall performance average. This knowledge is necessary before any changes in the organization structure are suggested. Asymmetries in

system behavior have been observed repeatedly in business operations. For example, one can intuitively see that the strain of a given degree of overcapacity may not be as costly as the opportunity cost of wasted capacity, and that a given degree of "efficiency" may not be equivalent to the same degree of "inefficiency," especially if the cause and effect are not reflected within the same subunit in the organization.

Once the components of each variance are obtained, in terms of the errors and the identifiable causal factors, then the square of the covariance becomes an expression of the product of the coefficient of determination and the sum of the products of the components of the variances taken two at a time. For example in a simple one-way analysis of variance we can estimate:

$$Cov^2(X,X') = \rho^2(S_e^2S_{e'}^2 + S_e^2S_B^2 + S_A^2S_{e'}^2 + S_A^2S_B^2)$$

where $\sigma_X^2 = E(S_e^2 + S_A^2)$ and

$\sigma_{X'}^2 = E(S_{e'}^2 + S_B^2)$

Now we concentrate on factors A and B, and their respective contributions to the covariance. Assuming that the performance variables X and X' of the subentities D and D' have been defined in a meaningful way--a topic to which we will return later--then a negative ρ implies a high degree of substitutability. Unless of course the interrelationship between X and X' is purely spurious, something which should become evident in the process of variance identification. On the basis of empirical observations, we have thus far been unable to find a purely spurious relationship between subentities within the firm, that is to say relationships that are not somehow reflected in the various A_i and B_i. If

such a rare occasion does present itself, then the organizational relationships between the subunits concerned will not be affected at all by any efforts to reduce the total variance.

In the absence of a spurious correlation, we usually find that X will be among the causal factors B_i of X', or the latter among the A_i. Given negative correlation, by means of relative centralization of units D and D' the variances are reduced, because the components which are due to some A_i and B_i approach zero, and as a result the sum of the new variances and obviously the combined variance are smaller than the sum of the original σ_X^2 and $\sigma_{X'}^2$. More important however, through co-ordination of plans and operations the expected value of both X and X' combined is raised over the sum of their previous expected values given the same inputs, because the wasted slack is extensively reduced. Thus the negative covariance is exploited for operating efficiency and reduction of the overall variations of plans from operations within the organization. To stress again, the important thing is not so much the elimination of the variance, but the exploitation of its causes for operating efficiency. The variance, as far as the information system is concerned, is the signal and not the goal.

Although, once an administrative change occurs it rarely leaves the previous lines of demarkation between subentities intact, yet we should for purposes of evaluation continue for a short period of time to collect dual data which will enable us to assess the desirability of the change.[3] If we do that, we will then find that the correlation coefficient between X and X' will definitely be affected by the reorganization. In the somewhat rare occasion where the relationship between the A_i and B_i is strictly "one-way" relationship, then it is possible that the correlation between X and X' may be reduced.

And this, because the variance of only one of the two activities may be affected and the operations of that subunit will exhibit a certain degree of non-correlation through the use of better and faster information. More often, however, both variances are reduced because of the use of common facilities and information, and as a result of the increased interdependence the correlation coefficient is increased. If there is a feedback between the factors that affect the performance of D and D' , and a feedback cycle is completed within the measurement period, then relative centralization will undoubtedly result in greater intercorrelation of results and smaller variances. In fact in this latter case of negative correlation and "immediate" feedback, complete fusion of D and D' is necessary. We must stress, however, that in every case, whether the relationship is "one-way" or "two-way", with or without feedback, the combined variance of the subunits upon recentralization should be much smaller than the sum of their previous variances, because the functional relationships that cause the negative correlation are translatable into operating efficiencies.

If the correlation coefficient is positive and the relationship is not spurious, then the complementarity may prove detrimental to the plans and operations of at least one of the two subunits, and thus result in overall inefficiencies. The solution here is to neutralize the adverse effects through relative decentralization, and attempt to discover any time lags between cause and effect for the purpose of devising a prognostic information system. The latter, will provide planning information, which will reduce even further the positive correlation between D and D' , and also filter external signals so as to take advantage of any asymmetries in the consequences of positive versus negative variations in the causal factors.

By studying the components of variances, we can, as in the case of negative correlation, identify cause and effect and concentrate on those A_i and B_i that need to be neutralized. It is by means of these functional relationships that we determine the type of reorganization and the degree of relative decentralization, and also choose the ingredients of the prognostic information system in case time lags are involved. The end result will be a reduction in the overall variance between plans and operations for the total organization, because:

(a) the variances of the positively correlated subentities will be reduced as a result of the relative neutralization of interdependencies, and

(b) the correlation coefficient will decrease, thus causing a further reduction in the covariance. The latter, if the relative decentralization is successful, although not completely eliminated, will not be much greater than the product of the correlation coefficient and the standard deviations of the two errors.

After the reorganization the subunits will be better able to pursue their tasks without external interference and achieve economies of specialization.

B. Time Lags and Feedback

We have already pointed out the importance of time lags in the design of information systems for planning and control. In analyzing the covariance of units within the firm, we will often find that not only time lags between cause and effect exist, but also "two-way" interrelationships. The latter, result in feedback systems and serially correlated performance variables. Once such relationships are detected they can be easily controlled and exploited for operational efficiency. The analysis of covariances will

enable us to perceive these interrelationships, and also assess their significance in generating the overall variance for the total organization.[4] If the variables which are negatively correlated are dominant, then we find in such situations that the performance of the total organization is oscillatory. If on the other hand the dominant variables are those which are positively correlated, then wide fluctuations will eventually bring about disintegration and explosive patterns of behavior if left unchecked.

Although time lags and two-way interrelationships between cause and effect complicate the analysis of organization structures, yet they are a blessing for purposes of designing an efficient information system of the firm. By providing a signal on the probable outcome of future events they aid planning, and also facilitate decisions relating to the allocation of resources and the control of operations. If efficiently used, such an information system will obviate the need for many corrective actions, because it will substitute prognosis for diagnosis.

C. Choice of Performance Variables

In the process of applying covariance analysis for assessing the efficiency of organization structures, one of the most delicate tasks one has to perform involves the choice of performance variables. On first sight it may appear that it is sufficient to use only purely controllable factors in measurement. While it is necessary that we do so in order to assess how controllable are the so called controllable factors, yet it is not sufficient.

A test on purely controllable factors will do nothing more than to determine whether the existing organization structure permits the subunits to control these variables without any external interference. This is a good starting

point. But who is to say that the existing organizational arrangements have not created extremely limited if not sterile subentities and that the artificial buffers that were interposed among subunits have not outlived their usefulness? So in addition to testing with performance variables reflecting the controllable factors, we must also test on the basis of variables reflecting the objectives of the subentities, especially as the latter relate to the total organization. Often this effort reveals glaring inconsistencies between the objectives of the firm and those of the subunits.

In the absence of such an all inclusive objective, one may resort to the output of the subentities or the revenue generated. Through this dual approach the analysis of covariance will generate functional relationships for both the production and the output or revenue functions. These relationships are very vital for the information system of the firm. One of them will assess the causes of variations due to reasons that are assumed to emanate from within the subunit, and the other will single out the external influences that show the real interdependence of all the subunits within the firm.

D. An Illustration

We will now abstract from an actual situation and illustrate some of the points that we have previously made.[5]

Let us assume that we have a firm engaged in management services. Its professional employees are grouped by specialities and for the most part make their own contacts with potential customers who normally have problems in their area of specialization. After the initial contact is made, the firm may give a tentative encouragement and the project leader then proceeds to make a research proposal. The latter may be preceded by a brief survey of the conditions within the firm, or what is more common it may be done independently.

Once the proposal is completed, it is submitted to the clients who after studying it either grant a contract or a negative answer. Upon receipt of a contract, the originator of the proposal becomes the project leader and manages the conduct of the research either alone or as a head of a group drawn for this specific purpose normally from among professional people within the department to which he belongs.

In analyzing the covariances generated within a firm of this nature, a seemingly strange interrelationship becomes apparent. The covariance between the level of capacity utilization of the professional departments--and as a result of the whole firm--and that of telephone calls and travel arrangements is quite large and negative. This is surprising on first sight, because the "output" of the subentities does not depend on a "common facility" to imply substitutability, nor is there any fundamental interrelationship between levels of activity and telephone and travel on an a priori basis.

The next step therefore involves analyses of the variances, for obtaining clues on methods for eliminating the overall variance and improving the efficiency of operations.

1. The telephone calls and travel activities: The hypothesis may be advanced for testing that the level of professional telephone calls and travel activities is a function of:

(a) the personal tastes of the professional employees, and

(b) the level of research activity of these people.

The number of personal calls placed by professional people for non-business reasons, are tested at various levels of research activity by means of a randomized complete block design, and reveal that there is no significant difference between the average number of personal calls placed by the employees

even at the 10 per cent level. Consequently, at this stage, any variations due to non-business calls are left to be reflected in the total random error, and the mean representing personal calls multiplied by the total number of professional people is subtracted from the total.[6]

A two-way analysis of variance shows that the hypothesis of equal use of telephone and travel[7] by professional employees for professional reasons is rejected at the 1 per cent level, and so is the hypothesis that the average use is the same at the various levels of research activity. Of the total variance in telephone and travel, approximately 50 per cent is due to the level of research activity of the people, showing that the busier they are the fewer calls and trips they arrange, 30 per cent due to personal differences, and 20 per cent due to random variation.

The level of research activity appears to affect the index of telephone and travel in two opposing ways. It is only logical to hypothesize that for conducting the research, writing the report, and finally presenting the results, the project leader and his team must do a certain amount of travel and calling on the telephone. So here we have a positive relation. On the other hand, calls and travel for contacts and new business are reduced when people are busy and increased when they are idle or operate below full capacity. Evidently, this negative correlation is much stronger than the positive correlation, in our example. By segregating our observations and testing, we find that the negative relationship between the level of research activity and telephone and travel is further increased and both the amounts explained by personal tastes and the random error are reduced.

2. The level of research activity: Although at any moment of time the functional relationship between research activities and telephone and travel

flows only in one way, from the former to the latter, yet in our illustration the analysis of variance for telephone and travel has revealed the possibility of a feedback with a time lag. So we trace the possible consequences of the contacts made through telephone and travel, and find that a certain predictable amount results in proposals approximately k weeks later, if a survey of the conditions within the firm is not undertaken, and $k + m$ weeks later if a preliminary study precedes the proposal. A percentage of all proposals becomes contracts with a mean lag of k' months from the point of the initial contact, showing that the firms which ask for a rather detailed proposal on the relevance of research to their own operations respond faster to the proposal than those who do not.

Intuitively we would expect that the level of overall business euphoria will affect the level of activity of a firm engaged in management services. This is found to be true with a time lag distributed around an average of k'' months. So the model to be tested expresses contracts at time t as a function of contacts made in period $t - k'$, and of the level of overall business expectations at time $t - k''$. Business activity is defined as a function of the annual profit rate for corporations, the future business outlook, the annual growth rate of National Income, and the rate of investment in plant and equipment, all of them as viewed at the same point of time. For each one of these factors, five levels are defined and numbers are assigned from one to five and an overall index for business activity is developed.[8]

A 5×4 factorial experiment with fixed factors is designed, and tested by using both one-way and two-way analyses of variance in order to isolate the effects of contacts, of the overall business level, and the interactions of the two. The results prove to be highly significant for both the contacts and the

level of overall business activity, thus rejecting the hypothesis that there are no effects attributed to these factors. The interaction of the two, however, is not significant.

The analysis shows that in terms of contribution to the total variance of the firm's professional activities, 65 per cent can be attributed to the level of telephone and travel contacts in period $t - k'$, 22 per cent to the overall level of business and economic outlook as viewed in period $t - k''$, 2 per cent due to the interaction between the main two factors, and 9 per cent to a random error.

We see, therefore, that a relatively innocuous negative covariance between the firm's utilization of capacity and its telephone and travel expenditures, revealed through analysis a pattern of dynamic interactions between future business and current operating capacity. This set of interrelationships, with the apparent dominance of the negative correlation between the efforts allocated to (a) existing research projects and (b) to future business, created an oscillatory pattern in the total revenue generated by the firms studied. Other factors, such as the expectations concerning the overall health of the business sector, cross-sectional differences in the level of activity within the firm, and differences in the average duration of projects undertaken, no doubt at times contributed toward mitigating and more often toward aggravating the fluctuations, depending on whether these indicators were out-of-phase or in-phase,[9] but of course never eliminated them.

In trying to arrive at a reorganization solution we are guided in this case by the following observations, which are obviously interrelated.

(1) A strong negative correlation and sizeable covariance between the levels of current capacity utilization and new business flowing in k' months later

(2) An almost perfect correlation and negative covariance between current capacity utilization and effort allocated toward cultivating new business potential, and

(3) A positive covariance and significant correlation between the operating levels of k' periods hence and the current telephone and travel activities.

The first two observations are due to an apparent excessive degree of substitutability, which if fundamental should lead to centralized planning and control of the activities involved, and the third should lead to decentralization because of the excessive complementarity. It is quite clear from what we have said that the fundamental and controlling interrelationship is (3), indicating that the greater the effort allocated to contacts and promotional activities, the greater the volume of future business. Consequently, if we were just to address ourselves to the first two observations, we will not succeed in eliminating much of the variance inherent in the operations.

The substitutability which is introduced by the use of a "common facility", the latter being the professional employee, is not basic but arose because of an administrative organizational design. Fundamentally, the existence of common facilities implies inherent economies of specialization which have already been achieved, standardized, and incorporated in the technology of the organization. But in the case at hand, we observe that the professional people are neither standardized nor are they all substitutable. On the contrary through their concentrated efforts they change the state of knowledge, so the greatest pay offs lie in their research efforts. Admittedly,

there is some transfer of knowledge between the research and the promotional efforts, in that the researcher to a certain extent can be his own best spokesman. This aspect, however, can be easily satisfied through co-ordination so that he enters into the promotional arena only when his presence is necessary. The latter must not be relegated to accidents of a particular moment of time.

Turning now to (3), the fundamental interrelationship that influences the other two, we find that in order to reduce the variability we definitely need to buffer or decouple future operating levels from current telephone and travel activities. This can be done by separating the research from the routine promotional efforts. Such an arrangement (relative decentralization) stabilizes the flow of new projects, because constant contacts are being maintained, and furthermore allows for greater specialization within both the research and promotional activities. In order to reduce unexpected variation even further and thus avoid the wasting of resources, information concerning the level of contacts made and the consequences of such must be transmitted to the operating divisions for conditioning their expectations. Thus the separation of the two functions eliminates the cyclical patterns that are perpetuated once generated, while the information system by giving data on cause and effect aids managerial planning and control efforts.

It is noteworthy, that in the cases tested the most revealing interrelationships did not come through the use of performance variables defined in terms of controllable factors (responsibility accounting), such as the number of calls completed per unit of time per person, or the number of dollars of new business brought in by the various people. They rather came through the use of <u>overall</u> financial accounting-budgetary classifications and for a good reason.

Through compartmentalization of organization structures, responsibility accounting attempts to buffer the various units, obscure the bonds of interdependence, and silence all external to the subunit interrelationships. The global accounting-budgetary model, however, no matter how imperfect, does not consciously attempt to eliminate the traces of interaction. It is exactly the set of assumptions behind the existing organization structure that we wish to re-examine and determine whether there is a need for reconsideration. In other words we wish to test inter-subentity interactions. That is why the overall financial accounting classifications usually provide a more fertile ground for analysis of interrelationships and eventual improvement of operations. In general, the more global are the performance variables chosen for testing interactions among subentities, the greater is the probability of successful reorganizations.

III. Implications for the Control System of the Firm

Elsewhere we have provided a justification for the control system of the firm, pointed out its probabilistic nature [3], and also have shown how we can extend the present standard accounting systems to probabilistic control systems [4]. We have laid the groundwork for a method by means of which observations are tested for probabilistic significance, courses of action are prescribed on the basis of stored decision rules, and then the variances are stored in the system to be tested if they converge to zero over the normalizing period, and also used in a Bayesean framework to provide sequential evidence of shifts in the assumed state of nature. Now we have suggested an extension to the above efforts, which will provide us with a check on the statistical significance of differences among otherwise assumed homogeneous entities, and also yield sets of functional interrelationships which can serve as a

basis for a meaningful information system for the firm. And all this, as a by-product of a design assessing the efficacy of existing organization structures in eliminating the variances generated within the firm and avoiding the wasting of resources. The elimination of variances occurs not through an accounting decree, but through analysis of the fundamental interrelationships between the various parts of the firm, selective transmission of information on cause and effect, and reorganizations that bring about efficiency.

A significant attribute of what we suggested previously [4] and of what we are suggesting now, is that the proposed system can function on existing accounting information, and refine them sequentially as the environmental conditions dictate. As anyone who is familiar with both the mathematics of analysis of variance and the accounting system of variance generation will attest, our suggestions can use accounting performance variances as basic input data.[10] No doubt, the covariance analysis will often point out the necessity for collecting data not previously available, and the lack of value in some of the perpetuated information. But the question arises, are there any fundamental implications of what we presented for the design of information and control systems of the firm?

The answer in our estimation is yes. We can see here the justification for a future accounting system based purely on functional relationships. Such a system will only store raw input data, and functional forms. As new data are received a check is made for probabilistic significance, covariances are analyzed, adjustments are made to the functional forms, if necessary, and the new forms are coded and finally stored. Among the latter will be forms which will provide over time justification for all changes in the basic functional

forms that have occurred. There will be practically no need for storage of processed information, and comparative studies for assessing efficiency and progress will then be made on a homogeneous basis. A lot of the problems that we now face in comparing financial results and separating the components of business income will thus be eliminated. What is more important, however, by using the input factors as a signal and checking against the stored forms, the information system will transmit to the various units within the firm the probable consequences of actions taken and the expected results because of the employment of resources. Such a system will serve as a motivating force for efficiency in designing the organization structure of the firm, by creating substabilities and then destroying them. The process of destruction will be carried on through changes in the organizational arrangements, as dictated by changes in the fundamental interrelationships governing the operations of the firm. Information on functional relationships will also facilitate learning and specialization within the subentities, thus bringing about further increases in productivity, further changes in the functional forms, and further structural reorganizations. This process is incessant and should be encouraged, and it is toward these ends that the system suggested in this paper is aimed.

Footnotes

[1]What we suggest here is the following. Given an organization within which each subunit plans independently and the factors that affect its performance are controlled by another unit, then the minimum of potential variance elimination and hence a measure of the potential efficiency to be achieved through reorganization, is reflected by twice the sum of the absolute covariances. In practice negative covariances do not really cancel out positive ones if planning is done on a decentralized basis so by means of centralization one may obtain "double action" out of negative covariances.

[2]Sometimes the organization structure succeeds in reducing the intensity of the covariance by artificial means without taking advantage of the functional relationships that exist. Consequently, all covariances must be initially studied and analyzed on the basis of alternative objective measures.

[3]Because complete separation of results subsequent to the change cannot be achieved, the indices will be prone to understate the impact of reorganization.

[4]Flow charts and engineering systems may give us an indication of the existence of some of these relationships. Without denying the supporting usefulness of these approaches yet we believe that neither is as flexible as the one suggested in this paper, nor do they provide any information on the statistical significance of the relationships. Furthermore, we are here interested not in an ad hoc method, but in one which will become an integral part of the information system of the firm.

[5]Although the fundamental interrelationships that are used in the example have been observed and high confidence can be placed on them, yet the quantitative aspects of these interactions are presented for purely illustrative purposes, and in no way should they be taken to represent the actual operations of any particular firm. Furthermore, not all of the observed interrelationships are analyzed, but only one set in order to reinforce our previous discussion.

[6]Note that this operation will not affect the correlation coefficient, the variance, or the covariance. Itis done in order to reveal the magnitude of the totals involved in case further investigation is considered desirable.

[7]What is tested here is an index combining the total number of calls and travel arrangements with their dollar magnitudes. In order to eliminate the impact of changes in the number of employees the index is calculated on a per employee basis. These adjustments yielded the best results.

[8]A much simpler index yielding almost as good results is based solely on projected business outlook.

[9]The experimental design for covariance-variance analysis provides a lot of this information as a by-product, and it should be considered in the solution for reorganization.

[10]The basic input data for analysis of variance in this case will be the accounting variances of subsidiary accounts, those of the relevant control account, and the number of observations included in each subsidiary total.

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